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Time-integrated Rb/Sr as a proxy for the composition of the new continental crust through time

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Recent models on continental growth suggest that 65-70% of the present volume of the continental crust was present by 3 Ga, and that the rates of continental growth were significantly higher before 3 Ga than subsequently. This change has been tentatively linked to the onset of subduction-driven plate tectonics and discrete subduction zones. If correct this represents a fundamental change in the evolution of the Earth, with implications for the nature of the magmas generated, the efficiency with which crustal material is returned back into the mantle and the cooling history of the Earth.

Geochemical constraints indicate that about 80% of the crust still preserved today was formed in subduction settings, with the rest being mostly related to intraplate magmatism (i.e. oceanic island and continental flood magmas). New continental crust that is currently formed and preserved along destructive plate margins, such as the Andes, has an intermediate/felsic-dominated composition that is similar to the composition of the bulk continental crust. In contrast crust formed in intraplate settings has a more mafic composition.

Because of the poor preservation of rocks and minerals after billions of years of crustal evolution, a major uncertainty remains about the composition of new, juvenile continental crust in the Hadean and the Archaean, and hence the conditions and the tectonic setting(s) in which it was generated. One way forward is to evaluate the composition of new continental crust from the time-integrated parent/daughter ratios of isotope systems in magmatic rocks subsequently derived from that new crust.

Because of the highly incompatible character of the Rb-Sr system, crustal differentiation processes produce a large range of highly fractionated Rb/Sr ratios. As a consequence mafic crust typically has Rb/Sr at least five times grater than intermediate/felsic bulk crust. We calculated time-integrated Rb/Sr in crustal material with pre- and post-3 Ga Nd model ages. Preliminary data indicate that time-integrated Rb/Sr were, on average, much lower in the Hadean/Mesoarchaean than subsequently. This suggests that new continental crust was principally mafic over the first 1.5 Ga of Earth evolution, that a large volume of pre-3 Ga crust may have been associated with intraplate magmatism, and that $\sim$3 Ga may indeed mark the onset of plate tectonics on Earth.